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ABSTRACT

This booklet contains information and activities on the life cycle of stars. Materials can be adapted for kindergarten through grade 8 classrooms. Background information on massive stars and medium stars and activities with subjects such as star life, constellation shapes, nebula terminology, astronomical distances, and pulsars is included. The 12 activities employ game formats such as crossword puzzles, word searches, and board games and are organized into two groups with different levels of difficulty. Matching poster is also included with booklet. (DDR)

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ED 461 494

An Information & Activity Booklet

Grades K-8

1997-1998

StarChild - a Learning Center for Young Astronomers

EG-1997(09)-003-GSFC

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STARCHILD presents...

The Life Cycles of Stars

Written by:

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Evans, GA

This booklet, along with its matching poster, is meant to be used in conjunction with the StarChild website or CD-ROM.

http://starchild.gsfc.nasa.gov/

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National Mathematics and Science Standards For the Activities in this Booklet

Space Squared - NSES Content Standard D for Grades 5-8
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Nebular Nonsense (level 1) - NSES Content Standard D for Grades K-4
NCTM Grades K-4 Standard 1

Star Scrambles - NSES Content Standard D for Grades K-4
NCTM Grades K-4 Standard 1

Those Amazing Stars - NSES Content Standard D for Grades 5-8
NCTM Grades 5-8 Standard 1

Nebular Nonsense (level 2) - NSES Content Standard D for Grades 5-8
NCTM Grades 5-8 Standard 1

Space Connection - NSES Content Standard D for Grades K-4

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Space Spirals (level 1) - NSES Content Standard D for Grades K-4
NCTM Grades K-4 Standard 1

Star Life - NSES Content Standard D for Grades K-4

Star Signs - NSES Content Standard D for Grades 5-8

Star Sketches - NSES Content Standard D for Grades K-4
NCTM Grades K-4 Standard 9

The Life Cycles of Stars

A star's life cycle is determined by its mass. The larger the mass, the shorter the life cycle. A star's mass is determined by the amount of matter that is available in its nebula, the giant cloud of gas and dust in which it is born. Over time, gravity pulls the hydrogen gas in the nebula together and it begins to spin. As the gas spins faster and faster, it heats up and is known as a protostar. Eventually the temperature reaches 15,000,000 °C and nuclear fusion occurs in the cloud's core. The cloud begins to glow brightly. At this stage, it contracts a little and becomes stable. It is now called a main sequence star and will remain in this stage, shining for millions or billions of years to come.

As the main sequence star glows, hydrogen in the core is converted into helium by nuclear fusion. When the hydrogen supply in the core begins to run out, the core becomes unstable and contracts. The outer shell of the star, which is still mostly hydrogen, starts to expand. As it expands, it cools and glows red. The star has now reached the red giant phase. It is red because it is cooler than it was in the main sequence star stage and it is a giant because the outer shell has expanded outward. All stars evolve the same way up to the red giant phase. The amount of mass a star has determines which of the following life cycle paths it will take after the red giant phase.

MEDIUM STARS

Throughout the red giant phase, the hydrogen gas in the outer shell continues to burn and the temperature in the core continues to increase. At 200,000,000 °C the helium atoms in the core fuse to form carbon atoms. The last of the hydrogen gas in the outer shell is blown away to form a ring around the core. This ring is called a planetary nebula. When the last of the helium atoms in the core are fused into carbon atoms, the medium size star begins to die. Gravity causes the last of the star's matter to collapse inward and compact. This is the white dwarf stage. At this stage, the star's matter is extremely dense. White dwarfs shine with a white hot light. Once all of their energy is gone, they no longer emit light. The star has now reached the black dwarf phase in which it will forever remain.

MASSIVE STARS

Once massive stars reach the red giant phase, the core temperature increases as carbon atoms are formed from the fusion of helium atoms. Gravity continues to pull carbon atoms together as the temperature increases forming oxygen, nitrogen, and eventually iron. At this point, fusion stops and the iron atoms start to absorb energy. This energy is eventually released in a powerful explosion called a supernova. A supernova can light up the sky for weeks. The temperature in a supernova can reach 1,000,000,000 °C. The core of a massive star that is 1.5 to 4 times as massive as our Sun ends up as a neutron star after the supernova. Neutron stars spin rapidly giving off radio waves. If the radio waves are emitted in pulses (due to the star's spin), these neutron stars are called pulsars. The core of a massive star that has 8 or more times the mass of our Sun remains massive after the supernova. No nuclear fusion is taking place to support the core, so it is swallowed by its own gravity. It has now become a black hole which readily attracts any matter and energy that comes near it. Black holes are not visible. They are detected by the X-rays which are given off as matter falls into the hole.

STAR LIFE - LEVEL 1

In the list below you will find the steps in the life cycle of a massive star. The steps are not in order. Carefully cut each step out with scissors. Using the information you have learned about massive stars, place the strips in the order in which they occur in a star's life cycle.

1. A supernova occurs.

2. Nuclear fusion occurs which causes the star to glow.

3. If it is a massive star, a neutron star forms. If it is a super massive star, a black hole forms.

4. Gravity pulls hydrogen gas together to form a cloud.

5. Iron, which acts as an energy sponge, forms within the star.

6. A red giant forms when the star's hydrogen level drops.

7. A main sequence star, which can live for millions or even billions of years, forms.

STAR SKETCHES - LEVEL 1

Long before the time of television, people told stories about the "pictures" they saw in the night sky. Many star groups were named for the people, animals, and objects our ancestors imagined when they looked at the stars. Use your imagination and other materials of your choice (crayons, stickers, glitter, etc.) to add to the star groups below. Create your own pictures using the stars as your guide.

CASSIOPEIA
THE QUEEN

URSA MINOR
THE LITTLE BEAR

CEPHEUS
THE KING

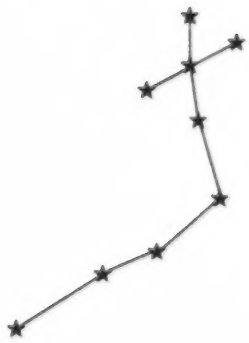
DRACO
THE DRAGON

STAR SKETCHES - LEVEL 1

CORONA BOREALIS
THE NORTHERN CROWN

LEO
THE LION

CANCER
THE CRAB



SERPENS
THE SNAKE

NEBULAR NONSENSE - LEVEL 1

How many star terms can you find hidden in the puzzle below? Words may be written horizontally, vertically, diagonally, left to right, or right to left. Circle each word as you find it.

STAR TERMS:
star gas heat galaxy fuel light dust atoms cloud

R F U E L R A
Y X A L A G T
D A L T G A I
U T S I E S R
O O L H G U U
L M T N E H S
C S F D U S T

10

SPACE SPIRALS - LEVEL 1

Complete the word spiral by filling in the star term described by each numbered clue. Write the first letter of the first answer in the box numbered 1. Fill in one letter per box moving clockwise around the spiral. The first letter of each answer should be written in a numbered box. Be careful! Each new word may overlap the word before it by one or more letters.

EXAMPLE:

1. planet closest to Earth
2. name of the star in our solar system
3. opposite of south
4. opposite of cold

1 M	A	R	2 S
4 H	O	T	U
T	R	0	3 N

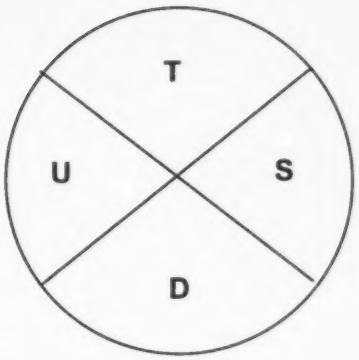
1. name given a new star
2. balls of gas giving off heat and light
3. powerful star explosion
4. force which pulls gas atoms together
5. the largest stars end their lives as _____ holes

1					2
	4				
		5			
					3

11

STAR SCRAMBLES - LEVEL 1

Words from the star text have been scrambled in the circles below. Your job is to unscramble the letters and write the correct word on the line under each circle.



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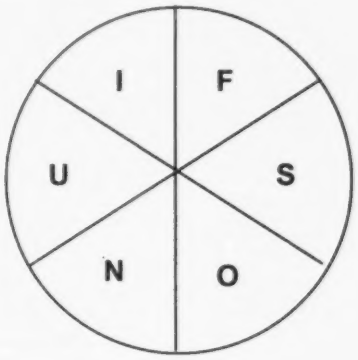

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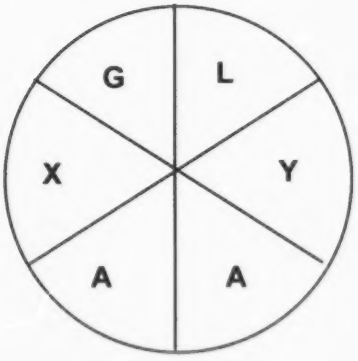

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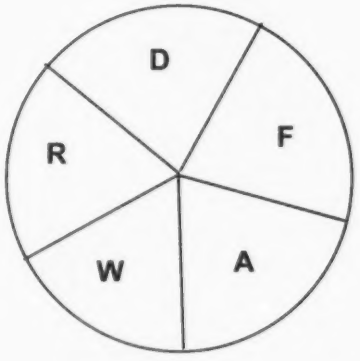

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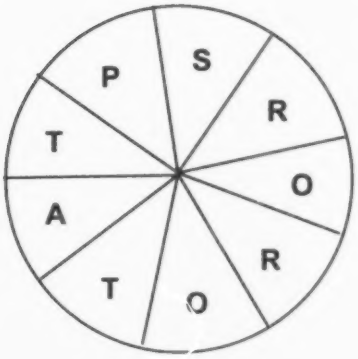
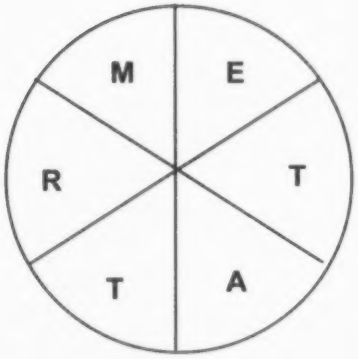
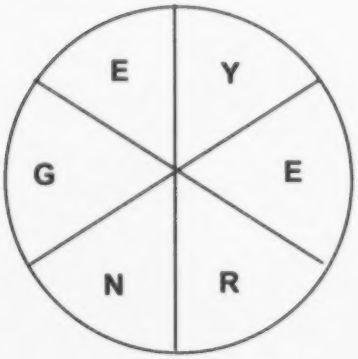
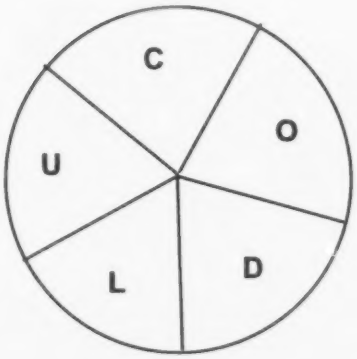

P
S
R
T
O
A
R
T
O


M
E
R
T
T
A


E
Y
G
E
N
R


C
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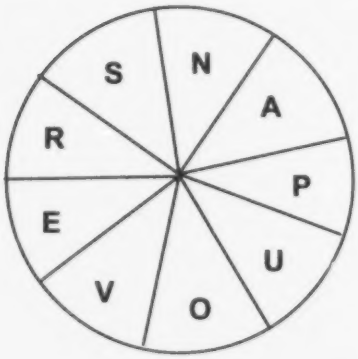
U
L
D


S
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V
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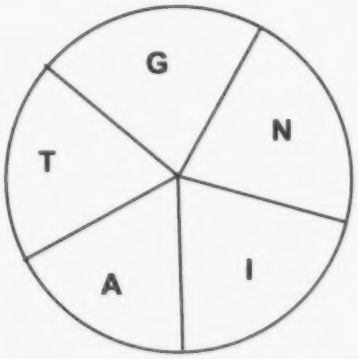

G
N
T
A
I

SPACE CONNECTION - LEVEL 1

Draw a line to connect each word to the group of words that best describes it.

1. Star	The medium size star in our solar system
2. Sun	To shine brightly
3. Core	A star that does not give off light
4. Glow	A glowing ball of gas
5. Red Giant	A giant explosion that took place in space a very long time ago
6. Expand	The middle
7. Black Dwarf	A large star that glows red
8. Big Bang	To grow larger

SPACE SQUARED - LEVEL 2

Joseph L. Lagrange was a French mathematician who lived from 1736 to 1813. He made many contributions to the field of mathematics, but the most notable were the calculus of variations and the development of the metric system. Lagrange was also an amateur astronomer. His two fields of interest, mathematics and astronomy, have been combined in this activity.

Joseph Lagrange proved conclusively that the Four Square Theorem was indeed a valid theorem. This theorem states that every positive integer is expressible as a sum of four or fewer square numbers. A square number is attained when a number is multiplied times itself (example: 3 X 3 = 9; 9 is a square number).

Below you will find the distances between selected space objects. Your mission is to take the underlined number and express it as a sum of four or fewer square numbers. There may be more than one right answer. The first one is done for you.

1. Earth to Barnard's Star - 6 lightyears
   Solution: $1 + 1 + 4 = 6 \quad (1x1 + 1x1 + 2x2)$
2. Earth to Ursa Major - 7 lightyears
3. Sun to Earth (average) - 150 million kilometers
4. Venus to Earth (average) - 42 million kilometers
5. Mercury to Mars (average) - 170 million kilometers
6. Earth to Pleiades Star Cluster - 400 lightyears
7. Uranus to Neptune (average) - 1630 million kilometers
8. Earth to the star Vega - 27 lightyears
9. Earth to M51: Whirlpool Galaxy - 14 million lightyears
10. Center of the Milky Way Galaxy to the Sun - 30,000 lightyears

DEEP SPACE DOUBLETS - LEVEL 2

Charles Dodgson (1832-1898) was an English mathematician who also happened to be an excellent storyteller. Using the name of Lewis Carroll, he wrote children's books that were full of whimsical nonsense. Among Dodgson's literary creations are such works as Alice's Adventures in Wonderland and Through the Looking-Glass. He was also an excellent photographer.

In response to the pleas of some young friends, Dodgson created word puzzles which came to be known as "doublets." To solve a "doublet," you must change one word into another by going through a series of steps. You may change only one letter at a time. Each change must result in the formation of a new word. The first starry word has been done for you.

1. Change mass to dust: mass
   mast
   must
   dust

2. Change gas to Sun

3. Change star to hole

4. Change core to X-ray

5. Change heat to glow

6. Change fuse to burn

7. Change mass to life

8. Change spin to glow

9. Change mass to cool

10. Change red to hot

SPACE SPIRALS - LEVEL 2

Complete the word spiral by filling in the star term described by each numbered clue. Write the first letter of the first answer in the box numbered 1. Fill in one letter per box moving clockwise around the spiral. The first letter of each answer should be written in a numbered box. Be careful! Each new word may overlap the word before it by one or more letters.

EXAMPLE:

1 M	A	R	2 S
4 H	O	T	U
T	R	0	3 N

1. planet closest to Earth
2. name of the star in our solar system
3. opposite of south
4. opposite of cold

1. takes place at 15,000,000 °C
2. rapidly spinning stars which emit radio waves
3. glowing balls of gas
4. ring around the core of a star
5. clouds of dust and gases in a galaxy
6. form of energy coming from black holes
7. nuclear fusion converts hydrogen into this element
8. the fusion of helium atoms form these
9. they give off pulses of radio waves
10. area of the cloud in which nuclear fusion takes place

1								
				5				
	8				10			
								2
				9			6	
4				7				
				3				

STAR SIGNS - LEVEL 2

Long before the time of television, movie theaters or video games our ancestors amused themselves by studying the night sky and telling stories about the pictures they saw there. The zodiac names we use today are actually the names our ancestors gave to special star groups known as constellations. How many of the ancient constellation names can you correctly identify? Place the constellation's letter on the line next to its description.

A. Gemini	_____ The Water Carrier
B. Cancer	_____ The Crab
C. Aries	_____ The Goat
D. Libra	_____ The Twins
E. Ursa Major	_____ The Dragon
F. Capricornus	_____ The Winged Horse
G. Leo	_____ The Scorpion
H. Draco	_____ The Bull
I. Pegasus	_____ The Archer
J. Taurus	_____ The Fish
K. Pisces	_____ The Hunter
L. Aquarius	_____ The Lion
M. Sagittarius	_____ The Scales
N. Scorpius	_____ The Ram
O. Orion	_____ The Great Bear

NEBULAR NONSENSE - LEVEL 2

How many star terms can you find hidden in the puzzle below? Words may be written horizontally, vertically, diagonally, left to right or right to left. Circle each word as you find it.

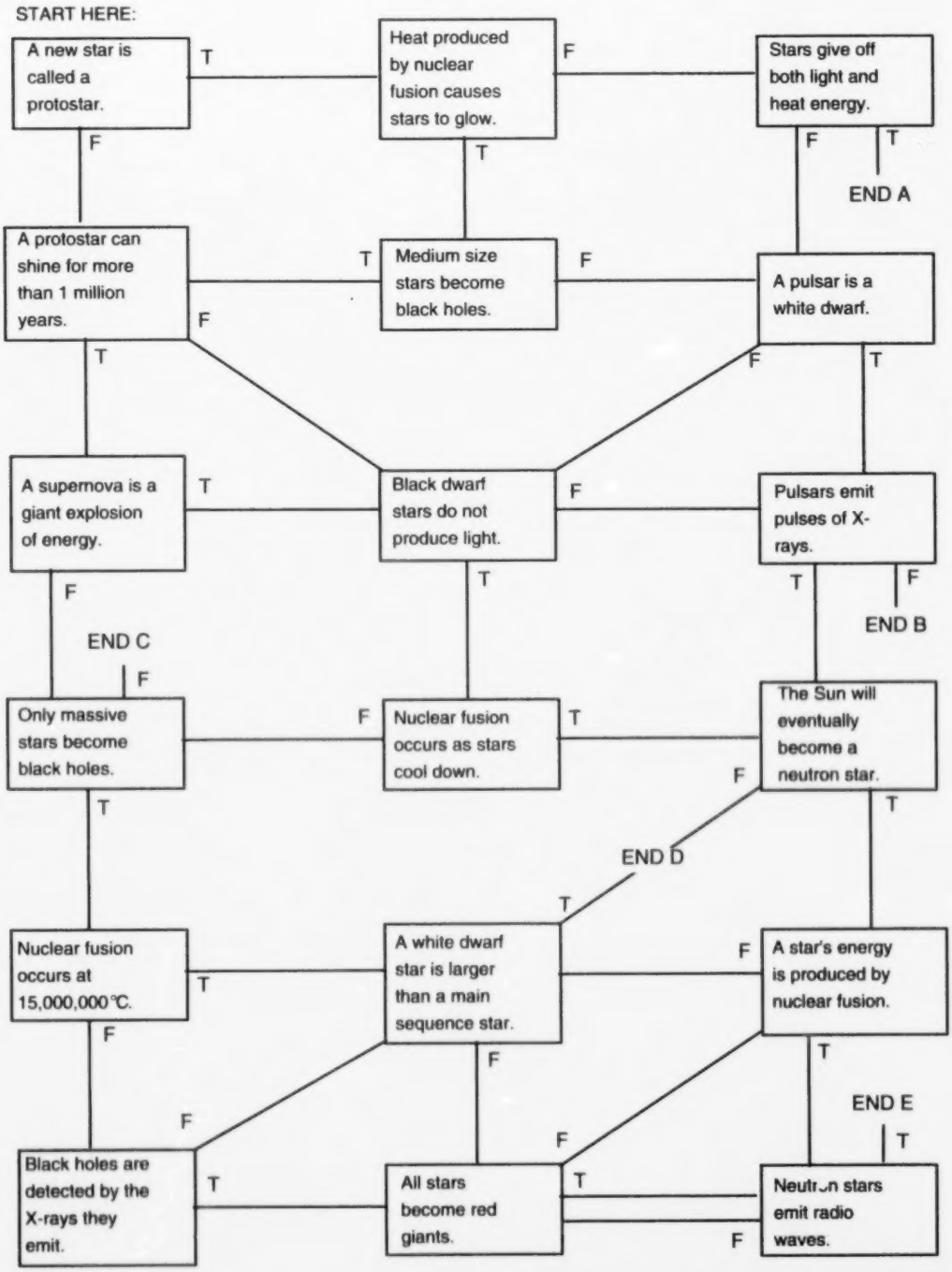
Star Terms:

hot, atoms, nebula, supernova, neutron, red giant, cycle, sphere, energy, fusion, core, galaxy, hydrogen, evolve, gas, cloud, glow, x-ray

N G F C E L S I U A A
E N T U L S D W C I L
B O N A S S P E O G U
U R A I H I M H R D B
L T I G Y E O O E E E
E U G A D T V N T R N
L E D L R O E L W A E
C N E A O R D U O L C
Y A R X G A S Y L V U
C T O Y E N A I G X E
A A V O N R E P U S N

THOSE A-MAZE-ING STARS - LEVEL 2

Use what you have learned about stars to find your way through the maze below. Begin at the start box, carefully read the statement in each box and decide if it is true or false. You will move from box to box by following the directional arrows (T = TRUE, F = FALSE). Continue to follow the arrows until you reach the true end of the maze (END E). All other exits are incorrect. If you exit at A, B, C, or D, retrace your steps to find where you got off track.

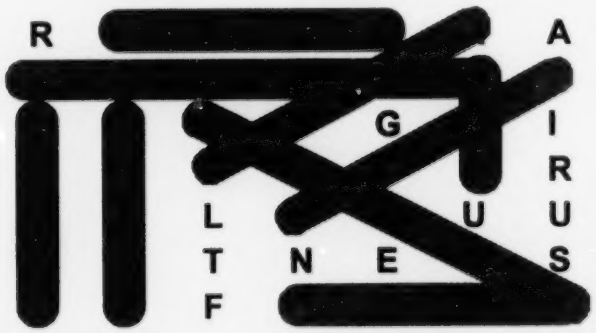

START HERE:
A new star is called a protostar.
Heat produced by nuclear fusion causes stars to glow.
Stars give off both light and heat energy.
END A
A protostar can shine for more than 1 million years.
Medium size stars become black holes.
A pulsar is a white dwarf.
A supernova is a giant explosion of energy.
Black dwarf stars do not produce light.
Pulsars emit pulses of X-rays.
END B
END C
Only massive stars become black holes.
Nuclear fusion occurs as stars cool down.
The Sun will eventually become a neutron star.
END D
Nuclear fusion occurs at 15,000,000°C.
A white dwarf star is larger than a main sequence star.
A star's energy is produced by nuclear fusion.
END E
Black holes are detected by the X-rays they emit.
All stars become red giants.
Neutron stars emit radio waves.

Solutions

STAR LIFE ANSWER KEY - LEVEL 1

1. Gravity pulls hydrogen gas together to form a cloud. (4)
2. Nuclear fusion occurs which causes the star to glow. (2)
3. A main sequence star, which can live for millions or even billions of years, forms. (7)
4. A red giant forms when the star's hydrogen level drops. (6)
5. Iron, which acts as an energy sponge, forms within the star. (5)
6. A supernova occurs. (1)
7. If it is a massive star, a neutron star forms. If it is a super massive star, a black hole forms. (3)

NEBULAR NONSENSE ANSWER KEY - LEVEL 1



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SPACE SPIRALS ANSWER KEY - LEVEL 1

1 p	r	o	t	o	2 s
a	4 g	r	a	v	t
v	a	c	k	i	a
o	l	5 b	y	t	r
n	r	e	p	u	3 s

STAR SCRAMBLES ANSWER KEY - LEVEL 1

1. DUST
2. FUSION
3. GALAXY
4. DWARF
5. PROTOSTAR
6. MATTER
7. ENERGY
8. CLOUD
9. SUPERNOVA
10. GIANT

SPACE CONNECTION ANSWER KEY - LEVEL 1

Draw a line to connect each word to the group of words that best describes it.

1. Star
2. Sun
3. Core
4. Glow
5. Red Giant
6. Expand
7. Black Dwarf
8. Big Bang
The medium size star in our solar system
To shine brightly
A star that does not give off light
A glowing ball of gas
A giant explosion that took place in space a very long time ago
The middle
A large star that glows red
To grow larger

SPACE SQUARED EXAMPLE KEY - LEVEL 2

2. 1 + 1 + 1 + 4 = 7 (1x1 + 1x1 + 1x1 + 2x2)

3. 100 + 25 + 25 = 150 (10x10 + 5x5 + 5x5)

4. 36 + 4 +1 + 1 = 42 (6x6 + 2x2 + 1x1 + 1x1)

5. 144 + 25 + 1 = 170 (12x12 + 5x5 + 1x1)

6. 256 + 36 + 4 + 4 + 400 (16x16 + 6x6 + 2x2 + 2x2)

7. 1600 + 25 + 4 + 1 = 1630 (40x40 + 5x5 + 2x2 + 1x1)

8. 25 + 1 + 1 = 27 (5x5 + 1x1 + 1x1)

9. 9 + 4 + 1 = 14 (3x3 + 2x2 + 1x1)

10. 28,900 + 900 + 100 + 100 = 30,000 (170x170 + 30x30 + 10x10 + 10x10)

DEEP SPACE DOUBLETS EXAMPLE KEY - LEVEL 2

2. gas
was
war
car
can
ran
run
Sun

3. star
spar
spat
slat
slap
slop
slot
soot
hoot
hood
hold
hole

4. core
care
bare
pare
part
pert
peat
beat
brat
bray
xray (X-ray)

5. heat
feat
flat
flaw
flow
glow

6. fuse
muse
must
most
post
pose
pore
tore
bore
born
burn

7. mass
mast
most
lost
loft
lift
life

8. spin
   spit
   slit
   slot
   slow
   glow

9. mass
   moss
   most
   molt
   bolt
   colt
   coat
   coal
   cool

10. red
    led
    let
    lot
    hot

SPACE SPIRALS ANSWER KEY - LEVEL 2

1 n	u	c	l	e	a	r	f	u
t	a	r	y	5 n	e	b	u	s
e	a	r	b	o	n	a	l	i
n	8 c	a	r	s	10 c	t	a	o
a	m	s	e	r	o	o	e	2 n
l	u	l	u	9 p	s	m	6 x	e
4 p	i	l	e	7 h	y	a	r	u
s	r	a	t	3 s	n	o	r	t

STAR SIGNS ANSWER KEY - LEVEL 2

A. Gemini
B. Cancer
C. Aries
D. Libra
E. Ursa Major
F. Capricornus
G. Leo
H. Draco
I. Pegasus

L The Water Carrier
B The Crab
F The Goat
A The Twins
H The Dragon
I The Winged Horse
N The Scorpion
J The Bull
M The Archer

J. Taurus — K The Fish

K. Pisces — O The Hunter

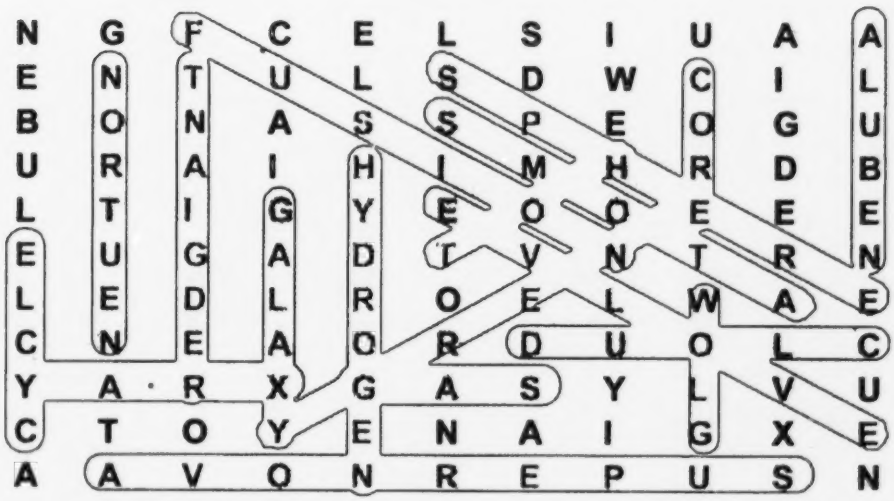
L. Aquarius — G The Lion

M. Sagittarius — D The Scales

N. Scorpius — C The Ram

O. Orion — E The Great Bear

NEBULAR NONSENSE ANSWER KEY - LEVEL 2


N G F C E L S I U A A
E N T U L S D W C I L
B O N A S S P E O G U
U R A I H I M H R D B
L T I G Y E O O E E E
E U G A D T V N T R N
L E D L R O E L W A E
C N E A O R D U O L C
Y A R X G A S Y L V U
C T O Y E N A I G X E
A A V O N R E P U S N

THOSE A-MAZE-ING STARS ANSWER KEY - LEVEL 2

1. A new star is called a protostar to
2. Heat produced . . . to
3. Medium size stars . . . to
4. A pulsar is . . . to
5. Black dwarf stars . . . to
6. Nuclear fusion occurs as stars . . . to
7. Only massive stars . . . to
8. Nuclear fusion occurs at . . . to
9. A white dwarf star . . . to
10. All stars become . . . to
11. Neutron stars emit . . . to
12. End E

Resources

Web Sites

- http://web.syr.edu:80/~jmlacivi/index.html
  This site covers the birth of a star from particles of gas and dust, the life cycle of the star, the grouping of stars into clusters and galaxies, and the eventual death of a star after millions of years.

- http://oposite.stsci.edu/pubinfo/amazing-space.html
  Part of the Hubble Space Telescope's Amazing Space site with interactive activities for kids. The current one under development is "Stars:birth, life, death, and rebirth."

Books

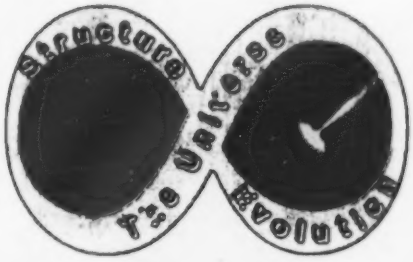
- *Universe* by William J. Kaufmann III, Freeman and Company, 1994. This book comes highly recommended from both students, and scientists. It explains many concepts in astronomy from cosmology to high-energy astrophysics, including information on stars (see chapter 18). Intended for the upper high school student with a strong science background and interest, or the undergraduate science major taking a basic astronomy course. A useful resource for teachers on all levels.

- *The Young Oxford Book of Astronomy* by Jacqueline & Simon Mitton, Oxford University Press, Inc., 1995. This book explains many concepts in astronomy from the Solar System, galaxies and the Universe. Intended for the middle or high school student.

- *How Far is a Star?* by Sidney Rosen, Carolrhoda Books, Inc.,1992. With cartoon characters leading the way, you'll find out much about the lives of stars, how big they are, and how far away they are in this question-and-answer book. Intended for students in elementary school.

About this Poster

The images on this poster are all artists' renditions. The neutron star is depicted to emphasize its powerful magnetic field. The black hole image shows the large accretion disk and jets surrounding the black hole, which cannot be seen.



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